# 4A

# Urban and Agricultural Water Pricing

This appendix is provided as background to respond to interest expressed by Bulletin 160-98 reviewers in water pricing information. Water prices in California vary widely, as discussed below. The more than 2,800 local agencies in California that provide water service establish their prices based on factors specific to their individual service areas, and those prices are generally reviewed by agencies' elected or appointed boards of directors, or by the California Public Utility Commission. Public agencies are not permitted to make a profit from their water sales, and the profits that privately owned water purveyors are allowed to make are established by the PUC.

## Water Retail Pricing

Many factors influence the prices charged by water agencies. For public water agencies, the types of charges they may levy depend upon the legislation under which they were created. Table 4A-1 shows types of California water supply agencies. Descriptions of the general powers of the public agencies shown in the table can be found in DWR's Bulletin 155-94, General Comparison of Water District Acts. Investor-owned utilities' water rates are set by the California Public Utilities Commission. Privately owned mutual water companies set rates for their members.

TABLE 4A-1

**Types of Local Supply Water Agencies in California[a]**

| *Type* | *Ownership* | *Number* |
|---|---|---|
| County Service Area | Public | 880 |
| Mutual Water Company | Private | 801 |
| Community Services District | Public | 309 |
| Investor-Owned Water Utility | Private | 195 |
| County Water District | Public | 178 |
| Water District | Public | 157 |
| Irrigation District | Public | 97 |
| Public Utility District | Public | 52 |
| Flood Control and Water Conservation District | Public | 41 |
| County Water Works District | Public | 40 |
| Municipal Water District | Public | 40 |
| Water Agency or Water Authority | Public | 31 |
| Water Conservation District | Public | 13 |
| Water Storage District | Public | 8 |
| Municipal Utility District | Public | 5 |
| Water Replenishment District | Public | 2 |
| Metropolitan Water District | Public | 1 |
| **Total** | | **2,850** |

[a] Water supply may also be provided by local agencies having other purposes (e.g., reclamation districts).

Source: Department of Health Services and State Controller's Office data, 1994-96.

### *Acquisition and Delivery Costs*

Acquisition costs are costs associated with obtaining water from a source. These costs may vary greatly from one source to another. Some water agencies have developed their own supply sources, some purchase water wholesale from larger agencies, and some have a mix of their own supplies plus wholesale purchases. Other costs include transportation and local delivery charges and water treatment costs. Supplies delivered for urban use require treatment, which is becoming an increasingly greater component of total cost as more stringent drinking water quality regulations are put into place. Compliance with surface water filtration and information collection requirements of the Safe Drinking Water Act, for example, is a substantial cost item for many water agencies.

Some water agencies use water rates to fully recover the costs of acquiring, treating, and delivering supplies, others use a combination of water rates and local property taxes. Another important consideration is whether a water agency sets its rates to reflect short-term or long-term costs. This is significant if a water agency's system is currently operating at capacity and major system improvements are needed. In this case, the water agency may have to increase rates to reflect the higher marginal costs of future system expansion.

During droughts, the rates water agencies charge may vary depending on supply availability. Agencies may have to acquire water from outside sources to meet service area needs or may have to construct interties or other conveyance system improvements to bring purchased supplies to their system. Many water agencies adopted higher rates to fund programs to encourage water conservation during the 1987-92 drought, and several implemented drought penalty rates intended to reduce water use drastically.

### *Characteristics of Service Area*

A water agency's costs will be affected by the mix of residential, commercial, industrial, governmental, and agricultural users within the service area because the cost of service to different classes of users is likely to be different. If a water agency serves a heavily populated area with many connections per square mile, the average fixed costs per customer will tend to be less. Conversely, if the purveyor serves a sparsely populated area, average fixed costs of serving each customer will normally be high. Because of pumping costs, changes in elevation within a service area can also affect delivery costs.

### *Rate Structure*

Water rates are the primary source of income for most water agencies. Although rates can be structured many ways, they typically include fixed charges, consumption-based charges, or both.

Fixed charges recover some or all of costs incurred regardless of the amount of water used, such as debt service incurred from project construction. Fixed charges are typically used by water agencies that do not meter consumption. Examples of fixed charges for metered urban water agencies include billing and administrative charges (service charges), lifeline charges for a minimum level of service, readiness to serve charges, and fire protection charges. Agricultural fixed charges (often called water availability or standby charges) can be levied on a per acre or connection basis. Fixed charges which are levied on a per acre or parcel basis will likely be affected by Proposition 218, discussed in more detail in Chapters 2 and 6.

Consumption-based charges are set on a per unit volume basis so the total charge varies with the user's consumption. These charges typically recover variable costs of water deliveries (water purchases, treatment, and pumping). As with fixed rates, there are several forms of consumption-based rates. One form is the constant charge, which is the same unit price for all units of water consumed. Another is block rates, which decrease (declining block) or increase (increasing block) with water consumption. A declining block rate sets a reduced price per unit for increased usage. Increasing block rates set increasing prices per unit for increased usage. Constant and increasing block rates are the predominant urban rate structures currently used in California. Some forms of declining rates are still used in urban areas, especially in communities using lower water rates as an incentive for industry to locate in their area. Some agencies use declining block rates and other incentives to encourage use of recycled water in lieu of potable supplies. Agricultural water agencies levy consumption-based charges based upon either the actual amount of water delivered or on the number of irrigated acres (charges may vary depending upon the crop type).

Fixed charges and consumption-based charges typically account for most of a water agency's total revenues. Revenues can also be obtained from assessments, or taxes, levied upon lands in accord with benefits received from an agency's actions. Assessments recover a portion of an agency's fixed costs, and can be levied either on lands which directly benefit from water deliveries (for example, land receiving irrigation water) or on lands which indirectly benefit from water deliveries (adjoining lands which may benefit from groundwater recharge resulting from the deliveries).

Cities may charge for sewers and sewage treatment based on water use. In some cities, the sewer charges are included in monthly service charges and commodity rates paid by the water users. Other cities charge for sewers based on water use, but keep the sewer charges separate from the water charges.

## Urban Retail Water Costs

Since 1990 there have been a few statewide surveys of urban retail water costs in California. One, conducted by the Department in 1991, included about 70 communities. The results of this survey are described in the Department's Bulletin 166-4, *Urban Water Use in California*. DHS conducted another survey in 1990, and three others were conducted by a private consulting firm in 1993, 1995, and 1997. (The 1993-1997 surveys were based on an assumed monthly consumption of 1,500 cubic feet of water per connection, an amount much lower than that used by many households. This assumption limits the usefulness of the survey data.) At a statewide level of coverage, there are no recent retail pricing data based on actual water use amounts.

In 1994, the accounting firm of Ernst & Young conducted a national water rates survey which MWDSC summarized in its 1995 Integrated Resources Plan. That survey showed that the national average for retail urban water supply was almost $600/af. MWDSC's average was about $625/af; San Francisco's was about $560/af; and Oakland's was almost $700/af. (Other urban areas had higher costs. Indianapolis was about $725/af; Houston was almost $900/af, and Nashville was more than $1,100/af.)

### *Impacts of Retail Prices on Water Use*

Price elasticity studies are used to characterize price responsiveness—the degree that water users increase or decrease use in response to a change in water price. Economists define price elasticity of demand as the ratio of the percentage change in quantity of water used to the percentage change in the price of water.

When faced with a significant water price increase, urban water users may react in one of three ways:

- They may use substantially less water. In this case, water users are sensitive to price changes, and demand is defined to be elastic (its absolute elasticity value is equal to or greater than one). For example, if a 10 percent increase in price caused a 10 percent reduction in demand, economists would define demand as elastic.
- They may use a little less water. In this case, water users are not very sensitive to price changes, and demand is said to be inelastic (absolute elasticity value is less than one). For example, if a 10 percent price increase caused a 5 percent reduction in demand, demand would be defined as inelastic.
- They may continue to use the same amount as before. In this case, the water users are completely insensitive to price changes, and demand is said to be perfectly inelastic (elasticity value is equal to zero).

A 1989 EBMUD study, for example, estimated price elasticity of demand for its residential water supply to be -0.202 from 1981 through 1987. This means that a water price increase of 10 percent could be expected to lower the amount of water use by about 2 percent. The demand for water in this case was inelastic—residential water users were found to be relatively insensitive to price changes. This has been the case for most studies of residential water demand.

Factors that can affect elasticity include climate, housing type, water users' income, percentage share of water bills in users' budgets, water rate structure, water conservation measures and education, and users' preferences regarding water use (some users may prefer to irrigate large turf areas regardless of cost). Table 4A-2 provides a survey of recent literature on urban water price elasticities of demand. These studies were performed with statistical modeling which employed historical water use, water price, and demographic and climatic data.

Elasticity estimates derived for one geographic area are not necessarily representative of another area because of these many potential variables. It is generally not correct to take a value of residential price elasticity estimated for one community during one period of time and to assume that it is applicable to another community, or for another period of time. Only by carefully examining the factors described above can elasticities developed under one set of circumstances be reasonably used for estimating elasticities under other circumstances.

For Bulletin 160-98, the Department contracted

TABLE 4A-2

**Urban Water Demand Price Elasticity Studies**

| *Author(s)* | *Study Date* | *Study Area* | *Type of Demand* | *Estimated Elasticity* | *Range of Study Water Prices* | *Equivalent Prices ($/af)[a]* |
|---|---|---|---|---|---|---|
| Moncur | 1987 | Honolulu, Hawaii | Short-term residential<br>Long-term residential | -0.265<br>-0.345 | $0.22 - $0.36 /1,000 gal (1983 dollars) | $72 - $117 |
| Metzner[a] | 1989 | San Francisco | Long-term residential | -0.25 | $0.73 - $0.78 /100 cu ft (1995 dollars) | $318 - $340 |
| Weber | 1989 | EBMUD | Long-term residential | -0.01 to -0.25 | $0.24 - $0.94 /100 cu ft (1989 dollars) | $105 - $409 |
| Nieswiadomy[b] & Molina | 1989 | Denton, Texas | Long-term residential | -0.55 to -0.86 | $0.27 - $0.56 /1,000 gal (1967 dollars) | $88 - $183 |
| Billings & Day | 1989 | Tucson, Arizona | Long-term residential | -0.72 | $6.60 - $11.20 monthly bills 1974 -1980 (1974 dollars) | $7 - $11 monthly bills |
| MWDSC | 1990 | South Coast Region | Long-term single-family residential<br>Summer<br>Winter | <br><br>-0.29 to -0.36<br>-0.03 to -0.16 | Not Available | Not Available |
| Schneider & Whitlach | 1991 | Columbus, Ohio | Short-term residential<br>Long-term residential<br>Short-term total urban<br>Long-term total urban | -0.262<br>-0.110<br>-0.504<br>-0.123 | Not Available | Not Available |
| Renwick et al. | 1996 | 8 California cities | Long-term single-family residential | -0.16 | $0.47-$4.25 /100 cu ft | $205-$1,851 |

[a] Water rate data was unavailable from the study author. The Department retrieved the historical data and inflated the prices to 1995 levels for display purposes only.

[b] Study was for summer months only and was a five-year period of recently adopted increasing block rates. Adjusted $R^2$ for models which produced -0.86 and -0.55 elasticities was only 0.26 and 0.11, respectively.

with University of California researchers for an evaluation of the effects of water pricing and non-pricing demand reduction actions (e.g., public education, rationing, subsidies for adoption of more efficient water use technologies) on urban residential water use. The study covered single-family residential use during 1989 to 1996, a time period incorporating the recent drought and allowing evaluation of actions taken by water purveyors to reduce residential water use during the drought. Eight water retailers whose service areas represent 24 percent of California's population were included—San Francisco PUC, Marin MWD, Contra Costa WD, East Bay MUD, City of San Bernardino, City of Santa Barbara, Los Angeles DWP, and City of San Diego. All of these agencies experienced price increases over the study period and all used

TABLE 4A-3

**DWR Survey of 1996 Agricultural Surface Water Costs[a]**

| *Region* | *1996 Total Deliveries (taf)* | *1996 Costs ($/af)* | | | *Water Rates Basis (number of agencies)* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Weighted Average* | *Max.* | *Min.* | *By Acre* | *By Crop & Acre* | *By af Used* | *By Acre & af Used* | *Total* |
| North Coast | 80 | 10 | 12 | 2 | 2 | 0 | 1 | 0 | 3 |
| San Francisco Bay[b] | — | — | — | — | — | — | — | — | — |
| Central Coast | 37 | 128 | 533 | 87 | 0 | 0 | 2 | 2 | 4 |
| South Coast | 92 | 373 | 604 | 131 | 0 | 0 | 1 | 7 | 8 |
| Sacramento River | 1,275 | 12 | 32 | 2 | 1 | 4 | 1 | 2 | 8 |
| San Joaquin River | 1,339 | 22 | 238 | 6 | 2 | 0 | 1 | 4 | 7 |
| Tulare Lake | 2,672 | 42 | 161 | 9 | 1 | 0 | 4 | 6 | 11 |
| North Lahontan[b] | — | — | — | — | — | — | — | — | — |
| South Lahontan | 18 | 61 | 61 | 61 | 0 | 0 | 1 | 0 | 1 |
| Colorado River | 3,403 | 13 | 14 | 8 | 2 | 0 | 0 | 2 | 4 |
| **Statewide** | **8,916** | — | — | — | **8** | **4** | **11** | **23** | **46** |

[a] Average retail costs to the farmer
[b] No responses

non-pricing demand reduction actions during the study period. Price elasticity was estimated to be -0.16 (meaning that a 10 percent price increase would result in a 1.6 percent demand reduction) over a range of marginal prices of $0.47 to $4.25 per hundred cubic feet, showing that residential demand was price inelastic over this range.

The urban water demand forecast used for Bulletin 160-98 assumed single-family residential price elasticities of -0.1 for winter months and -0.2 for summer months. Studies of urban water pricing to date indicate that the role of pricing by itself in achieving demand reduction is small. The plot of urban water production over time shown in Figure 4-4 illustrated the strong response of water use to the 1987-92 drought. Actions taken by water agencies during the drought to encourage demand reduction—including public education programs, voluntary rationing, rebates for plumbing retrofits—decreased residential water use. However, water use throughout the State is rebounding to earlier levels, even after significant price increases by some agencies. For example, Contra Costa WD increased its average water rates substantially to finance construction of Los Vaqueros Reservoir. Between 1980 and 1997, CCWD's average water price increased by about 217 percent (adjusted for inflation). Its use per residential unit declined by 9 percent, much of which is likely due to plumbing retrofit and building code requirements for new plumbing, and public education.

## Agricultural Water Costs

In December 1996, the Department mailed water cost surveys to more than 60 agricultural water agencies in California. This survey was conducted to determine the range of average agricultural retail surface water costs in the State and to obtain information on types of water charges being used. Table 4A-3 summarizes the results of this survey by hydrologic region. Many responding agencies based their charges on both water use and number of acres irrigated. The information is presented here to illustrate the variability of prices based on local circumstances.

Agricultural groundwater costs vary considerably throughout California. Factors influencing these costs include depth to groundwater, water quality, and well yields. Many groundwater users are self-supplied, meaning that individual water users pump their own supplies rather than receiving them from a water agency. Bulletin 160-93 showed general ranges of agricultural groundwater production costs. The Department does not have sufficient new data to accurately update those general cost ranges for Bulletin 160-98.

### *Impacts of Price on Agricultural Water Use*

Price elasticity of demand for agricultural water is a measure of farmers' responsiveness to changes in the price of water. Researchers have used a variety of models (programming and econometrics) to estimate the agricultural water use price elasticity in different parts of the country, and have concluded that demand for irrigation water is generally price inelastic, within price ranges typical for agricultural water use. Obviously, there is no other commodity that can be substituted for the water needed to grow crops. As Table 4A-4 illustrates, water costs are typically a relatively small percentage of the total cost of producing most crops. The Central Valley Production Model was used to estimate agricultural price elasticity in the Central Valley. CVPM price elasticity estimates for irrigation water demand are based on the level of production of various crops. CVPM also allows for changes in cropping patterns as water becomes more scarce, more expensive, or both.

Results of CVPM studies are summarized in Table 4A-5. Surface water prices were increased for the study by different increments, and groundwater costs increased as a result of changes in pumping depths. Both short- and long-term elasticities were estimated. In the short-term study, it was assumed that farmers did not have enough time to adjust to increases in water costs, while in the long-term farmers could switch to more efficient irrigation technologies.

The values in the table are estimates of a farmer's ability to respond to water price changes. For example, if surface water prices increase by 10 percent in the Sacramento Valley, the demand for surface water will decline by 3.2 percent. The model runs indicated that demand for irrigation water was price inelastic over the price ranges analyzed. Where groundwater is available in the Central Valley, farmers may increase their groundwater use if pumping costs are less than the costs of their surface water supplies.

TABLE 4A-4

**Average Water Costs as a Percent of Total Production Costs for Selected Crops in the Tulare Lake Region[a]**

| *Crop* | *Water Costs as a Percent of Total Costs* |
|---|---|
| Irrigated pasture | 36 |
| Alfalfa hay | 19 |
| Barley | 16 |
| Dry beans | 14 |
| Wheat | 14 |
| Cotton | 12 |
| Sugar Beets | 12 |
| Safflower | 11 |
| Dry Onions | 9 |
| Almonds | 6 |
| Pistachios | 6 |
| Processing tomatoes | 6 |
| Wine grapes | 5 |

[a] Data from output of the Department's Central Valley Net Crop Revenue Model.

## *CVPIA Tiered Pricing*

Section 3405(d) of CVPIA required that new, renewed, or amended contracts for project water incorporate an inverted block rate pricing structure specified in the act. The first rate tier applied to a quantity of water up to 80 percent of the contract total. The second rate tier applied to the quantity of water from 80 percent to 90 percent of the water under contract, and was to be halfway between the rate for the first tier and the third tier. The third tier applied to the quantity of water beyond 90 percent of the contract total, and was to be not less than USBR's full cost rate. USBR's municipal and industrial customers are already charged the full cost rate, which includes cost of service, principal and interest on facility construction costs, and CVPIA Restoration Fund charges.

As noted in Chapter 2, all of USBR's contract renewals to date have been interim renewals, since the PEIS required by the act has not yet been completed. No long-term renewal contracts can be executed until USBR completes the PEIS, which is now expected to occur in 1999. Through 1996, interim contracts for project water supply represented about 16 percent of project water under contract.

In its 1998 public draft PEIS, USBR used CVPM to estimate potential impacts of implementing tiered pricing as set forth in the act. USBR estimated that implementing tiered pricing would reduce average year CVP applied irrigation water in the CVP service area

TABLE 4A-5

**Price Elasticities for Surface Water Irrigation Demand**

| *Region* | *Short-Term Elasticity* | *Long-Term Elasticity* | *Range of Water Prices ($/af)* |
|---|---|---|---|
| Sacramento River | -0.24 | -0.32 | 20 - 240 |
| San Joaquin River | -0.20 | -0.30 | 20 - 240 |
| Tulare Lake | -0.18 | -0.24 | 20 - 240 |

by 266 taf from CVPIA's assumed no-action condition. This amount took into consideration the shift from CVP water use to groundwater use, in those areas having access to groundwater supplies. (The estimate assumed that USBR's ability to pay policy for irrigation remained in effect for principal on capital and Restoration Fund charges, at an estimated payment capacity of $11/af north of the Delta and $70/af south of the Delta.)

USBR also evaluated alternatives to the tiered pricing specified in the act, including an analysis which assumed that ability to pay provisions were not in force. This approach would reduce applied irrigation water by an additional 25 taf in an average water year. The greatest reduction in applied irrigation water use occurred in USBR's alternative which exceeded the requirements of the statute by applying full cost pricing to the first 80 percent of contract water supply, 110 percent of full cost pricing to the second tier, and 120 percent of full cost pricing to the last 10 percent of contract water supply. The draft PEIS estimated that this alternative would reduce applied irrigation water by about 570 taf in an average year.

After USBR completes the CVPIA PEIS, long-term contract renewals can begin. The effects of tiered pricing on CVP water use will be manifested over time, as more contracts are renewed. The relationship of CVP tiered pricing to CVP water use, however, cannot necessarily be generalized to price/water use relationships for agricultural users served from non-USBR sources. Agricultural water users served by the SWP, local water projects, and self-supplied sources already pay full cost rates for their supplies.

## Comparing Agricultural and Urban Water Costs

Generally, agricultural water supply costs are lower than urban costs. Much of the State's earliest large-scale water development was for agriculture, and the irrigation works were constructed when water development was inexpensive by present standards. Also, there are basic differences in the delivery systems providing agricultural and urban water supplies. The price of water is determined by the cost of water at the source (from a reservoir or at the Delta, for example) plus the costs of using the facilities associated with conveying, storing, treating, and delivering the water to the final users. Some contracts for agricultural supplies have allowed agricultural users to pay a lower price for water supplies in return for accepting supplies with a lower level of reliability. Typically this was achieved by deficiency provisions incorporated in the water supply contracts.

Both urban and agricultural water agencies must pay transportation costs incurred to bring the water supplies to their service areas. However, agricultural agencies are often closer to the surface water sources and in many cases are able to rely on gravity-operated conveyance and distribution systems, avoiding energy costs associated with pressurized pipelines. Urban water supplies often travel through hundreds of miles of canals or pipelines, adding considerably to the transportation costs. For example, by 2000, power costs to deliver SWP water to the San Joaquin Valley service area are estimated to be about $15/af. Power costs to deliver the same acre-foot of SWP water to the South Bay, Central Coast, and Southern California service areas are estimated to be about $34, $78, and $87, respectively.

Urban water systems have additional delivery costs compared to agricultural systems. For example, urban water users must pay for terminal storage and pressurization of water. Monitoring and treating water for public health protection is expensive, and costs are expected to increase as a result of more stringent drinking water standards. Most urban water systems also incur substantial costs to install and read meters, and to prepare billings.